10 February 1975

MEMORANDUM FOR THE RECORD

25X1 SUBJECT: [redacted] Computer Model

Background

To ensure that stated and expected customer demands for communications services can be fulfilled, a formal Network Improvement program has been initiated. While such a plan will necessarily include many variables, network topology and protocol are two areas of special concern. With the ever increasing utilization of satellite communications that results in a concentration of communications capability at selected nodes, it is becoming increasingly important to ensure that nodal equipments have the inherent capability to handle the increased traffic volumes resulting from new and expanding services. Of equal importance, is the ability to accurately project link and nodal requirements in various degrees of degraded network operation. Since many of the stated customer requirements will exceed present satellite power allocations, certain changes may be required in today's environment of free-wheeling dedicated underutilized circuitry. New techniques for communicating information in a limited resource environment must be carefully and accurately examined prior to procurement. While the narrative network of the past did allow the above areas of concern to be examined by manual methods, the combination of new services and the increasing need for more sophisticated methods of communicating makes this no longer practical. To ensure that the Office of Communications is adequately prepared to support its various customers, there exists a need to accurately analyze the
25X1 performance of the [redacted] The use of a computer for simulation appears to be a viable approach.

The Model

While the Office of Communications is just today looking at expanding the available services from solely narrative to various forms of data transmissions, other government agencies have already offered such services. To accurately plan their expanding networks, the DCA Defense Communications Engineering

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Center has spent many man-years of effort perfecting a model with sufficient flexibility that almost all network configurations can be portrayed. The resultant model, with a specially written Simulation Operating Language, is a composite of many models widely used today. It has been extensively used in AUTODIN network planning and is being used as the basis for AUTODIN II (IDN) planning where many sophisticated concepts, including packet switching, are being explored.

The model provides an event-by-event simulation of actual network performance. Input parameters include traffic addressing patterns of each tributary, hourly volumes and priority distribution, individual station operating hours, tributary-nodal and nodal-nodal configurations, nodal (MAX) characterization, and specific link capabilities.

The operation of the network can be simulated for any time period. The data base will be subdivided into hourly statistics allowing "snapshots" of network performance to be taken at that minimal interval. If, for example, one week of operation is simulated, the traffic flow and queue levels by priority can be obtained at any point in the network for any hour. The impact of reterminating tributary stations on the old node as well as the new and resultant impact on transmission links can be readily ascertained. Failures of satellites, entry terminals and base stations can be simulated and resultant network operation analyzed and compared to other alternate routing plans. The implementation of front-end processors (PCTG's) on the MAX system can be simulated. Since this model does require substantiaal processing times for the simulation, it is generally run in the batch mode. Results, however, are put on tape for analysis in the time shared mode from a remote terminal.

In addition to the above described event-by-event network model, another model is also available that is based on analytical simulation. While this particular model is not as accurate as the above since traffic patterns are assumed to take certain distribution patterns that are analytically defined, it does allow more variables to be examined in an interactive manner by performing the simulation in the time

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shared mode rather than the batch mode. Therefore, changes in network topology can be more quickly although less accurately studied. Hybrid communications circuits consisting of combinations of HF, satellite and landline with independent error distributions can be analyzed for overall performance. New error control techniques that include varieties of forward error correcting and automatic repeat request can also be simulated. The various line protocol techniques found in different demand access systems can be examined for network throughput and minimum response times. It can be seen that this analytical model would be a very useful tool for grossly examining various communications concepts while the above event-by-event model would provide a more accurate description of actual network performance.

Resource Requirements

While the development of the above models has required the significant expenditure of funds and man-hours, Dr. Crawford, Chief, Modeling and Simulation Branch, DCEC, has indicated his willingness to provide the programs and initial assistance necessary to adapt their models to the [redacted] Representatives of the Applications Division, OJCS, have been examining the model in detail and, at this time, the consensus of opinion is that the program will be adaptable to their computer systems. What is required, then, is to compile the required data base. While much of the data is available from MAX summary log reports, certain additional data will be required from each field terminal. This will basically include traffic patterns obtainable from the channel check logs and hourly traffic volumes. This information will, however, be required for Agency traffic as well [redacted] Hence, the cooperation of these organizations will be required.

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Recommendation

In view of the numerous areas in which such a program could prove beneficial and considering that the only resource expenditure will be in the man-hours required to compile the data and then exercise the model, it is recommended that that simulation effort be allowed to continue. Once the initial

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simulation is obtained, the performance of the model will be analyzed for accuracy by comparing it with known queue statistics. This will then allow another reappraisal to determine if further refinements are justified.

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